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Idaho Water Resources Research Institute
University of Idaho
Idaho

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Idaho Water Resources Research Institute
University of Idaho
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ABSTRACT

This reports on the research and information dissemination activities of the Idaho Water Resources Research Institute during the 1985 fiscal year. Synopses are presented for the following research projects: Development and Evaluation of Procedures for Systems Analysis and Optimization of On-Farm Irrigaton Systems: Ground Water Management Under the Appropriation Doctrine; A Chemical Speciation Approach to Evaluate Water Quality Problems in the Blackbird Mining District, Idaho; Blue-Green Algae Toxicity in Black Lake, Kootenai County, Idaho; A SAS Based Hydrologic Information Storage and Retrieval System and Preparation of a Booklet Dealing with Health Aspects of Drinking Backcountry Water. Information dissemination and workshop activity of the Institute is also reported.

Water Problems and Issues of Idaho

The most important problem facing the state of Idaho over the last few years, and for many years to come, is that of water allocation in the Snake River Basin.

The first step in the solution of this problem was made two years ago when the Idaho legislature passed the Swan Falls Agreement. This agreement defined the amount of water which Idaho Power can use for hydropower production as well as the amount which is available for upstream consumptive use. The legislature appropriated $700,000 for hydrologic studies and the beginning phase of the adjudication for the entire Snake River Basin. The Idaho Department of Water Resources estimates that the adjudication will require at least ten years and an expenditure of nearly $30,000,000, the majority of which will be funded by a tax on water users in the affected area. The Idaho Water Resources Research Institute is currently involved in three research projects concerned with the Snake River adjudication.

The Institute also has an active program in efficient management of irrigation water. Good management entails efficient use of both water and energy. Research management has been sponsored by several outside agencies, and an annual irrigation management workshop is sponsored by the Institute. The Institute is currently involved in four projects concerned with water and energy efficiency.

Although the state has, in general, excellent water quality, there a number of problems. In northern Idaho these are mostly concerned with water quality in recreational lakes and the possibility of contamination of ground water leaving the lakes. In addition, there are heavy metal problems as well as toxic algae blooms bproblems within these lakes. Water quality problems in sourthern Idaho are due to irrigation return flow, toxic waste dumps and abandoned mine tailings drainage. The Institute currently has these projects concered with these problems. Many of these problems are relatively isolated and the general water quality is very good; however it is important to "clean up" the problems that we have as quickly as possible.

Program's Goals and Priorities

The basic goals and priorities of the Institute's program are as follows:

1. To promote research that is relevant to state and regional needs for conservation of water and related land resources with emphasis on economic resource development, preservation and enhancement of environmental quality and social well being of people.

2. To stimulate, coordinate and provide leadership for water resources research in the established units of the universities of the state of Idaho and to cooperate with sister institutions in adjoining states. Such research should utilize an interdisciplinary approach and provide opportunities for training of students.

3. To cooperate with and help local entities, state and federal government agencies to carry out their responsibilities concerned with water and related land resources and to provide public involvement in identifying research needs.

4. To provide for dissemination of research findings in an expeditious and comprehendable manner to interested persons.

5. To develop funding for needed research and to encourage cooperation with regional research organizations in conducting an efficient and productive research effort.

Solving any of water resources problems in the state involves five steps.

1. The problem must be identified by consultation with people affected by the problem.

2. An individual or several individuals must be identified who have expertise that may solve the problem.

3. A funding source must be identified which may even be private individuals concerned with the problem.

4. The researchers must develop a proposal and present it to the funding agency or individuals.

5. The research is accomplished and the information disseminated to any persons that may be involved in this or similar problems.

The majority of the grant funds was used to fund a total of four research projects concerned with ground water management, toxic algae, irrigation water management and arsenic speciation and acid mine drainage and two information dissemination projects concerned with hydrologic data base management and developing booklets for getting information on Giardia Lambia to the general public. The remainder of the grant was used for information dissemination, office expenses and travel for the administration of the program. Most of the travel money was used to attend meetings within the state of Idaho, to inform people of the Institute and its activities with respect to water problems. Much of the information dissemination work involves answering requests for publications. Price of the publication covers the direct copying charges, it does not cover the secretarial expenses and general office expenses. A portion of the administrative monies was used by Dr. Charles Brockway, Associate Director of the Institute, who is stationed in sourthern Idaho and maintains contact with various local, state and federal agencies concerned with water problems and their solutions.

Synopsis

Project Number: 02

Start: 5/85
End: 6/87

Title: Development and Evaluation of Procedures for Systems Analysis and Optimization of On-Farm Irrigation Systems

Investigators: Busch, J.R. and King, B.A., University of Idaho, Moscow

COWRR: 06A Congressional District: First

Descriptors: Irrigation, systems analysis, irrigation design

Problem and research objectives: The overall objective of this project is to develop and test a procedure for critically evaluating on-farm irrigation system plans and water management practices for site specific conditions.

Specific objectives are:

1. To develop means of determining the operating characteristics and costs of irrigation system components including various application systems -- surface, sprinkler and trickle. Factors to be considered include pumping energy requirements and costs of system components operating under site-specific conditions along with soils information, topography, water delivery, cropping practices, climatic conditions and irrigation practices including management practices.

2. To develop and test a simulation model for on-farm irrigation systems using appropriate systems analysis techniques. Output from the model will consist of a detailed analysis of irrigation system operation by the farm and system layout, soils, crops and and rotations, management and labor, water supply, legal factors, energy costs and availability and other pertinent factors.

3. To develop and test optimization techniques for obtaining maximum crop production (and/or maximum net benefits) as influenced by irrigation system design and operation at the farm level.

NOTE: The first two objectives of this project have been addressed in the first year of the study. The third objective is being addressed in the second year.

Methodology: University researchers have utilized available resources of both government agencies and private entities in pursuing the objectives of this project. Close contact has been maintained with the USDA Soil Conservation Service (SCS) and the USDA Agricultural Research Service (ARS) as these agencies are actively involved with irrigation systems planning, design and research. Digital computer models for

different aspects of irrigation system design and operation have been written and modified. Whenever possible, existing state-of-the-art models and procedures have been obtained and modified for the systems analysis procedures of this project. All models have been adapted to run on microcomputers (IBM-PC compatible) so that they can be used by extention personnel, field technicians and small consulting firms.

The entire procedure consists of a number of models and programs. Data are entered using a computer spreadsheet to provide ease of entry and editing. The simulation models for both component functions and overall system operation are written in FORTRAN 77 code and are linked together for simulating the operation of an entire system. Individual models can also be run independently so a user can evaluate the operational characteristics of one type of component (e.g. a sprinkler irrigation system or a border irrigation system).

Principal findings and significance: Microcomputer based models have been developed for major types of irrigation application system in the pacific Northwest. They are as follows:

1. Border model -- This model is based on the zero-inertia model of Strelkof. The computer model, written at the University of Idaho (UI), produces results (advance, recession and application efficiency) that agree with baseline data. A recent updated aero-inertia model has also been obtained from the USDA Water Research Laboratory in Phoenix and adapted for use on a microcomputer. On a microcomputer, the UI model runs approximately 100 times faster than the USDA model and produces similar results for graded borders with slopes greater than 0.1 percent. The USDA model is suitable for use on no-slope borders whereas the UI model can be used only for slopes greater than 0.1 percent. The UI model contains an optimizing routine that computes the optimum streamsize and application time for maximum application efficiency.

2. Furrow model -- A kinematic wave model has been adapted for use in modeling the operational characteristics of furrow irrigation systems. An optimizing routine in included in this model to adjust furrow stream size to maximize application efficiency for given furrow parameters.

3. Sprinkler models -- Models for two categories of sprinklers have been developed; one for self-propelled systems including center-pivot and linear-move systems, and the model for these systems was adapted for system planning purposes from a detailed design model written by L. G. James of Washington State University. This model provides the needed information regarding system efficiencies and operating characteristics with the minimal amount of data generally available to planners. Likewise, the operating characteristics and efficiencies for hand-line and side-roll systems are computed with the set-move model. Included in the sprinkler models is an erosion model developed by the Soil Conservation Service based on the Universal Soil Loss Equation.

4. Ditch and pipe-sizing models -- A model has been developed and tested for obtaining net irrigation water requirements. Crop mix and evapotranspiration data are combined with rainfall data in computing average daily net irrigation requirements for different cumulative periods. The information generated by this model is used to select irrigation system component types and/or sizes based upon net water requirements.

5. Net irrigation requirements -- A model has been developed and tested for obtaining net irrigation water requirements. Crop mix and evapotranspiration data are combined with rainfall data in computing average daily net irrigation requirements for different cumulative periods. The information generated by this model is used to select irrigation system component types and/or sizes based upon net water requirements.

In addition to the five models listed, work is proceeding on developing the irrigation system simulation procedure incorporating optimization techniques. A method for determining optimal irrigation priorities throughout the irrigation season is based upon crop water production functions and crop values. This procedure will be coupled with other optimization procedures in accomplishing the third objective.

Another major effort of this project deals with determining the uncertainties involved in the modeling process. A method is being developed for identifying the various parameters most critical to the simulation model predictions and the relationships between the input and output parameters. The results of this aspect will include estimates of the level of error in computed design parameters resulting from error introduced into data through various sources. Also, a range of accuracy and level of acceptance on the computed outputs will be established using statistical tests.

Publications and professional presentations: None

M.S. theses: None

Ph.D. dissertations:

Kim, S., Development and Evaluation of Procedures for System Analysis and Optimization of On-Farm Irrigation Systems. Ph.D. dissertation in Agricultural Engineering. Expected completion date: May, 1987.

Synopsis

Project Number: 03 Start: 5/85
End: 6/88

Title: Ground Water Management Under the Appropriation Doctrine

Investigators: Ralston, D.R., University of Idaho, Moscow

COWRR: 04B Congressional District: First

Descriptors: Ground water management, appropriation

Problem and research objectives: Solutions to water resource problems dealing with conjunctive use of surface water and ground water generally have been developed on either a local or statewide basis. Little information transfer has occurred from one state to another in the identification and solution of these kinds of problems. The classification and analysis of ground water - surface water problems in the ten western states of Idaho, Washington, Oregon, Montana, Wyoming, Utah, Nevada, Arizona, Colorado and New Mexico and their integration into a single document is very important. This is a significant step in seeking innovative solutions to water resource management problems. Similarly, the compilation and integration of management plans and activities are equally important in the preparation of a document that will be an important guideline for ground water management under the appropriation doctrine in the western United States.

Methodology: Research in the first year of effort has included analyzing management tools and management practices for ground water resource development in Idaho, Oregon, Washington, and Montana. Work has focused on the management alternatives presented in the legal codes of the various states, the ways in which the management guidelines have applied in the areas of ground water development, and identification of attitudes toward ground water management within the state water management agencies. Continued research will focus on comparison of historic management activities in these and other western states for areas that are hydrogeologically similar.

Principal findings and significance: Research completed to date allows identification of a range of applications of the appropriation doctrine to ground water. Designation of an area as critical is common to the states investigated. A difference exists between whether the state or local individuals initiate the designation process. All states note the importance of adjudication of rights in the ground water management process. Adjudications have been completed only for a few areas. The Cottonwood area of Idaho is the only area where application of the recharge limitation has followed adjudication of rights.

Most of the state water resources administrators indicated a reluctance to declare an area critical or initiate an adjudication without some local input or support. The Blue Gulch area of Idaho is an example where a state initiated adjudication was stopped because of local opposition. The Butter Creek area in Oregon has been declared critical by the state three times only to have the order repealed because of suits filed against the State Department of Water Resources.

Ground water management is a topic of major concern in Idaho, Oregon and Washington. Bills pertaining to management questions have been proposed in all three state legislatures. The problems being addressed in the individual states are controlled by the hydrologic aspects of ground water pumpage areas. For example, surface water - ground water conjunctive use is a dominant topic in Idaho because of stream depletion questions with respect to the Snake River at Swan Falls.

Publications and professional presentations: None

M.S. theses:

Bruhl, Elliot, Ground water management under the appropriation doctrine. M. S. thesis in Geology. Expected completion date: May, 1987.

Ph.D. dissertations: None

Synopsis

Project Number: 04 Start: 05/85
End: 06/85

Title: A Chemical Speciation Approach to Evaluate Water Quality Problems in the Blackbird Mining District, Idaho

Investigators: Wai, C.M. and Mok W. M., University of Idaho, Moscow

COWRR: 05A Congressional District: First

Descriptors: Chemical, speciation, water quality

Problem and research objectives: The Blackbird Mine, located at the edge of the Frank Church Primitive Area in east-central Idaho, is one of the largest domestic sources of cobalt in the United States. Mining operations from the 1940's to the 1960's left many wastepiles and dumps in this area. Sediments in the streams surrounding the mining area are contaminated with high concentrations of arsenic, cobalt, and copper. The Blackbird Mine, reopened for several years in the early 80's, was closed down again in 1984. Because the mine is not in operation, data collected at the present time provides us with actual levels of various metals in surrounding streams, and also enables us to evalaute the effects of contaminated sediments on water quality of this economically and environmentally important area. This report presents the current levels of arsenic, cobalt, copper, iron, and manganese in creek waters and the results of leaching of these metals from representative sediments collected from the Blackbird area. The observed water quality data are correlated with the amount of arsenic species, As(III) and As(V), found in the system.

The objectives of this study were to obtain information on current water quality data from the Blackbird area, to study leaching behaviors of various metals from contaminated sediments, and to evaluate the possibility of using the arsenic species as a chemical indicator for predicting water quality problems.

Methodology: A solvent extraction method has been developed for the measurement of As(III) and As(V) species in water by neutron activation analysis. This technique which is capable of detecting ppb levels of arsenic in natural waters, was used for arsenic speciation studies of the Blackbird area. Other metals in water and in sediment samples were analyzed by atomic absorption spectrometry. Leaching experiments were performed in the laboratory in beakers with magnetic stirring. Field samples were collected from Blackbird Creek and from Panther Creek between the fall of 1985 and the spring of 1986.

Principal findings and significance: Blackbird Creek drains the mining site and flows into Panther Creek which is a tributary of the Salmon River. The background levels of cobalt and copper in creek water,

measured at unpolluted locations of Panther Creek above the confluence of Blackbird Creek, are very low, about 0.01 ug/mL (10 ppb) or less. The natural arsenic concentration in Panther Creek is about 1 ng/mL (1 ppb) or less, with the majority of the arsenic in the pentavalent states, As(V). Elevated levels of cobalt and copper, in ug/mL (ppm) range, were observed in Blackbird Creek. The iron and manganese contents in Blackbird Creek water are also high but the total arsenic concentration is not significantly different from the natural background level. However, a higher As(III)/As(V) ratio was generally observed. Below the confluence of Blackbird Creek and Panther Creek dilution by natural water from the latter results in significant lowering of the metal levels in the creek. The predominant arsenic species in the Panther Creek below the confluence is As(V).

The arsenic and cobalt contents in the sediments of Blackbird Creek are generally in the range of 0.1 to 1 mg/g. The sediments are often brown in color, indicating the presence of oxidized iron. Leaching of these sediments in open air with stirring resulted in a ppm level of cobalt and copper and a ppb level of arsenic in the leach solution. A significant fraction of the leached arsenic is in the trivalent state As(III). The amount of arsenic leached appears to be related to the iron content of the sediments. Similar leaching experiments carried out in the laboratory with the sediments collected from Panther Creek gave much lower cobalt and copper concentrations but showed about the same level of arsenic in the leach solution. Leaching of metals from sediments was found the follow first order kinetics. The contaminated sediments in the creeks appear to be potential non-point sources of pollution for the aquifer of the Blackbird area.

Publications and professional presentations:

Mok, W.M. and Wai, C.M., Extraction of As(III)-As(V) and Sb(III)-Sb(V) species in natural waters for neutron activation analysis. Presented at the 41th Northwest Regional Meeting of the American Chemical Society, Portland, Oregon, June, 1986.

Mok, W.M. and Wai, C.M., Simultaneous extraction of pentavalent and trivalent species of arsenic and antimony from natural waters for neutron activation analysis. Manuscript submitted to Analytical Chemistry for publication, July 1986.

M.S. theses: None

Ph.D. dissertations:

Mok, W.M., Chemical speciation of antimony and arsenic in natural water systems and its applications to environmental problems. Ph.D. dissertation in Chemistry, University of Idaho. Expected completion date: May, 1987.

Synopsis

Project Number: 05

Start: 06/84
End: 06/86

Title: Blue-green Algae Toxicity in Black Lake, Kootenai County, Idaho

Investigators: Falter, C.M. and Kann, J., University of Idaho, Moscow

COWRR: 05A Congressional District: First

Descriptors: Algae, toxicity

Problem and research objectives: Increasing occurrences of explosive growths or blooms of blue-green algae in lakes through out the western United States have been linked to recreational use, sewage inputs, and non-point runoff associated with agriculture and grazing. In certain instances these blooms produce a toxin which can be lethal to fish, aquatic invertebrates, mammals and humans. Black Lake in northern Idaho has experienced massive late summer and fall growths of a toxic algae, Anabaena flos-aquae (Nostoc commune). Demonstrated fatal toxicity to cattle and small mammals has resulted in four of the last five years. Little is known of the exact environmental conditions required to cause toxicity, nor can the timing, intensity, or occurrence of toxicity be predicted at this time.

Objectives of this project were to document the biological elements and timing of toxic blue-green blooms; to relate the biological elements and timing to the physical, and chemical environment before and during the bloom occurrence; to determine bloom toxicity throughout the above sequence; and to develop annual loading of nitrogen and phosphorus to Black Lake.

Methodology: We have established a lake monitoring plan to document specific aspects of Black Lake phytoplankton development through the summer-fall period. Concurrently, we have been measuring salient physical and chemical parameters at various points of the water column. These controllers have been selected for their known controlling influence on algae growth. To assess nutrient loading we are determining discharge and nutrient concentrations of all significant inflows to the lake.

Principal findings and significance: Although conditions seemed favorable, and other blooms were intermittent through the summer-fall 1984, Anabaena flos-aquae did not develop to bloom proportions and toxicity did not occur. A toxic bloom did, however, occur in September 1985. A comparison of limnological and climatological parameters between the two years of "no toxicity" and "toxicity" may explain some of the causal mechanism of the toxic bloom in Black Lake.

Morphometric variables determined from bathymetric soundings taken in 1984 reveal that Black Lake has steep sides and a relatively flat bottom (bathtub shaped). This lake's basin shape translates to a mean depth which is high relative to the maximum depth, (4.27 m and 7.3 m, respectively). This morphomentric relationship is important in light of Black Lake's stratification pattern. At times when the lake is strongly stratified (June, July and August), waters below 5.0 m become anaerobic. Due to Black Lake's bathtub shape, this means that 55% of the benthic sediments underlie an anaerobic layer of water. Black Lake sediments contain very high reserves of particulate phosphorus (1523.7 mg per kg of sediment). Under anaerobic conditions a portion of this particulate form will be converted to the dissolved form. This dissolved phosphorus is converted to the dissolved form. This dissolved phosphorus is then released to the water column during fall growth. Therefore, the potential for a large nutrient release (particularly phosphorus) and a subsequent toxic bloom is greatly increased when Black Lake is strongly stratified.

A comparison of temperature and rainfall patterns between 1984 and 1985 reveal that the months preceeding and during stratification had an average of 3 degrees C lower temperature and 10 cm more rainfall in 1984. This caused weaker stratification and the absence of a well developed anaerobic hypolimnion. There was then no large nutrient release from the sediments and no massive Anabaena bloom in 1984. In contrast, the hotter, dryer weather of 1985 caused strong stratification and a well developed anaerobic hypolimnion. A massive bloom then occurred in early September, and bioassays showed toxicity to mice at 0.75 ml bloom water per i. p. injection.

The relationships between climate, stratification, and morphometry is important in explaining some of the causal mechanism responsible for a toxic Anabaena bloom in Black Lake.

Publications and professional presentations:

Kann, J., and Falter, C.M., Blue-green algae toxicity in Black Lake, Kootenai County, Idaho. Idaho Water Resources Research Institute technical completion report. September, 1985.

Kann, J., and Falter, C.M., Controlling factors of a toxic blue-green bloom in Black Lake. Paper presented to Idaho American Fisheries Society state meeting. March, 1986

M.S. theses:

Kann, J., Blue-green algae toxicity in Black Lake, Kootenai County, Idaho. M.S. thesis in Fisheries in progress. Expected completion date: December, 1986.

Ph.D. dissertations: None

Synopsis

Project Number: 23

Start: 05/85
End: 05/87

Title: A SAS Based Hydrologic Information Storage and Retrieval System

Investigators: Molanu, M., and Bluske, M.J., University of Idaho, Moscow

COWRR: 10B Congressional District: First

Descriptors: Climatic data, data base management, SAS system

Problem and research objectives: HISARS, a hydrologic data base system, is currently used by many individual and organizations to retrieve water resource information. However, due to the present design of the system and the lack of PL/I programmers at the University of Idaho, the maintenance of HISARS has become a difficult task. In particular, the addition of new data is a slow process, requiring a significant amount of reprogramming whenever input formats are changed. Thus, users do not always have access to the most up-to-date information. Another problem with HISARS is the inability to modify the system for new applications; it is difficult to provide users with new output formats or more processing options.

Therefore, the objective is to replace HISARS with a SAS based storage and retrieval system called the Northwest Hydrologic Information Management System (NHIMS). With NHIMS, users will be able to easily access the data as they do now, seeing few, if any, changes. However, the SAS system provides procedures for resolving the current problems with adding and editing data. Also, SAS programmers will have the flexibility to write their own routines to create unique output formats or to perform additional analyses not now available.

Methodology: The main goal of the NHIMS project is to design a system that is easy for the system manager to maintain and that will preserve and increase the ease of data retrieval for system users. Regarding maintainability, the macro language within the SAS software package will be used to create a modular, loosley-coupled system; maintenance programmers will be able to add or modify individual macro operations without affecting the entire system. Also, all of the NHIMS data will be stored in permenent SAS data sets; thus, one can take advantage of the built-in procedures offered by the SAS system to easily edit, update or document those data sets. Design considerations such as clarity of programming, consistency in data set structure, and complete and accurate documentation will be highly stressed in order to improve system maintainability.

In order to preserve the ease of data retrieval, the existing HISARS command language will be supported in NHIMS. Current users will access information as they do now, issuing a few simple commands in a specified format; advanced programming skills will not be needed to use the system. Furthermore, experienced SAS programmers will be able to access the data sets and to use the macro library independently of the NHIMS system.

Due to the large size of the data sets in the system, efficiency of data retrieval is also a major concern. The SAS software system provides for direct access of SAS data sets by use of the POINT option on the SET statement. The POINT option is used in conjunction with a pointer file, which acts as a map of a particular data set, to directly access a range of observations without having to perform a sequential search. In this way, the SAS system can stimulate ISAM file operations.

Principal findings and significance: At this point in the project, all of the HISARS data files have been converted to permanent SAS data sets and are ready for use with full documentation available. Programs have been written to perform sample data retrievals, proving the ability of the POINT option to do direct access. A small-scale simulation has successfully shown that users will be able to employ the existing command language to retrieve information, even though it is SAS software which is now doing the internal operations.

The final steps of the overall project, which will be completed in the coming year, are to finish the design of the NHIMS programs and to implement and test the program code. Both a user's manual and a programmer's manual will be written to describe how to use the new system. In addition, upon project completion, workshop will be held to show users how the NHIMS system can give them access to pertinent hydrological data.

Publications and professional presentations:

Bluske, M.J., and Molnau, Myron. SAS Software for managing climatic data. Accepted for presentation for 1986 meeting of the American Society of Agriculture Engineers.

Bluske, M.J. File descriptions for the H+NHIMS system. Department of Agricultural Engineering, University of Idaho, Moscow. 1986.

M.S. theses:

Bluske, M.J. Software requirements documentation for the NHIMS system. Graduate paper for M.S. degree in Computer Science. Department of Agricultural Engineering, University of Idaho, Moscow.

Ph.D. dissertations: None

Synopsis

Project Number: 24

Start: 05/85
End: 06/86

Title: Preparation of a Booklet Dealing with the Health Aspects of Drinking Backcountry Water

Investigators: Minshall, G.W. and Brock, J.R., Idaho State University, Pocatello

COWRR: 10C Congressional District: First

Descriptors: Water quality, standards, guidelines

Problem and research objectives: Giardiasis became, during the decade following 1975, the leading known cause of waterborne disease nationally as well as in Idaho. While other modes of transmission, including outbreaks associated with public water systems contributed numerous cases, equal or greater number of illnesses were attributed to consumption of unpurified water by backcountry recreators. Recreation was a major contributor to Idaho's economy, with activities such as hunting, fishing, rafting, and backpacking pursued by residents as well as tourists from out of state. As of 1985, most users of the Idaho backcountry had heard mention of microbial contaminants in water which could affect their health, but the public lacked a source of accurate information on the extent of, and solutions to, the apparent problem. Our research, conducted in 1984, on the prevalence of giardiasis in commercial river guides on the Middle Fork of the Salmon River elicited numerous requests for further information on the suitability of various water purification techniques. The guides indicated that resource managers and accounts in the popular press had proliferated information about water quality concerns which conflicted with what the professional boatment thought was correct. There appeared to be a need by the public and professionals alike for a clear, concise authoritative discussion of the issues related to Giardia and other potential health hazards associated with recreational use of the backcountry.

The objectives of this information dissemination project were to conduct presentations and prepare publications which would provide the public with information pertaining to:

1. An awareness of the potential hazards involved in drinking water from any nondomestic source.

2. The distribution and biology of Giardia and the symptoms, epidemiology, prevention, and treatment of giardiasis.

3. The options available for water purification, including specific methods and their effectiveness.

4. Other potential sources of disease for the backcountry user with suggested preventive measures.

While these objectives were intended specifically to meet the needs of Idaho residents, it was hoped that the publications would, in addition, fill an apparent lack on the national level of information oriented towards prevention of the spread of disease among backcountry recreators.

Methodology: Manuscripts of two publications were prepared. The first, a two-page brochure, was intended to inform the hunter, backpacker, fisherman, and boater of the health aspects of the backcountry travel. The leaflet has a poster format on one side to facilitate posting on bulletin boards at trailheads, campgrounds, and visitor information centers. The handout gave details to those individuals interested in additional information on how they could obtain the second publication, which is the book dealing with the topic in greater detail.

Principal findings and significance: Significant interest and need for information regarding Giardia.

Publications and professional presentations:

Minshall, G.W. and Brock, J.T., Backcountry water: Giardia and other potential health hazards. Two-page color brochure. Idaho Water Resources Research Institute. 1986. Moscow, Idaho.

Brock, J. T., Backcountry water: Giardia and other potential health hazards. Manuscript in review. Idaho Water Resources Research Institute, Moscow, Idaho. Idaho State University, Pocatello.

Brock, J.T., Health effects of water quality on the Middle Fork with implications for outfitters and guides. Idaho Outfitters and Guides Association, Spring meeting. April, 1986. Boise, Idaho.

Brock, J.T., Microbiological quality of water in the Middle Fork of the Salmon River and the prevalence of intestinal parasites among commercial river guides. State of Idaho, Department of Health and Welfare. May, 1985. Boise, Idaho.

Brock, J.T., Creatures that lurk under the surface: Giardia and other health hazards in the Middle Fork country of the Salmon River. Challis National Forest. June, 1986. Challis, Idaho.

M.S. theses: None

Ph.D. dissertations: None

Information Transfer Activities

The principal information transfer activities are:

1. An irrigation short course presented in Kennewick, Washington, November 7 and 8, 1985. The topic was irrigation management, and the audience was primarily irrigation managers and engineers.

2. A total of four newsletters were printed during the year which contained such information as activities of the Institute, other activities associated with water in the state, calendar of events and director's comments.

3. A Water Resources Seminar was conducted during the fall semester. This seminar had an enrollment of nine students and the semester topic was water quality problems in the state of Idaho. A total of 12 invited speakers presented the seminars. These speakers were from on campus and from such agencies as the Forest Service, the Division of Environment and other state agencies.

4. A total of 124 publications were furnished on request to various people.

5. The professional publications submitted during the year are as follows:

Bluske, M.J. File descriptions for the NHIMS system. Department of Agricultural Engineering, University of Idaho, Moscow. 1986.

Bluske, M.J. Software requirements documentation for the NHIMS system. Graduate paper for M.S. degree in Computer Science. Department of Agricultural Engineering, University of Idaho, Moscow.

Brock, J. T., Backcountry water: Giardia and other potential health hazards. Manuscript in review. Idaho Water Resources Research Institute, Moscow, Idaho. Idaho State University, Pocatello.

Brock, J.T., Creatures that lurk under the surface: Giardia and other health hazards in the Middle Fork country of the Salmon River. Challis National Forest. June, 1986. Challis, Idaho.

Brock, J.T., Microbiological quality of water in the Middle Fork of the Salmon River and the prevalence of intestinal parasites among commercial river guides. State of Idaho, Department of Health and Welfare. May, 1985. Boise, Idaho.

Kann, J., and Falter, C.M., Blue-green algae toxicity in Black Lake, Kootenai County, Idaho. Idaho Water Resources Research Institute technical completion report. September, 1985.

Kann, J., Blue-green algae toxicity in Black Lake, Kootenai County, Idaho. M.S. thesis, Department of Fisheries, University of Idaho. Expected completion date: December, 1986.

Minshall, G.W. and Brock, J.T., Backcountry water: Giardia and other potential health hazards. Two-page color brochure. Idaho Water Resources Research Institute. 1986. Moscow, Idaho.

Mok, W.M. and Wai, C.M., Simultaneous extraction of pentavalent and trivalent species of arsenic and antimony from natural waters for neutron activation analysis. Manuscript submitted to Analytical Chemistry for publication, July 1986.

Mok, W.M., Chemical speciation of antimony and arsenic in natural water systems and its applications to environmental problem, Ph. D. dissertation, Department of Chemistry, University of Idaho. Expected completion date: May, 1987.

Cooperative Arrangements

Cooperative arrangement and projects are conducted with the following organizations:

Idaho Department of Water Resources
Bureau of Reclamation
Water District I
NASA
Corps of Engineers
Twin Lakes Improvement Association
Payette County
Bear River Commission
Kidd Island Bay Reclamation Association

The Institute has cooperated with the Montana, Washington, Utah and Oregon Institutes in either short courses or research projects. The Institute has also started an Idaho Technical Committee on Hydrology which meets once a month to discuss with various federal, state and local agencies the status of water problems in the Snake River drainage.

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Training Accomplishments

Academic Disciplines	Academic Level				
	Undergraduate	Master's Degree	Ph.D. Degree	Post Ph.D.	Total
Engineering					
--Agricultural	2		1		3
--Mechanical	1				1
Fisheries, Wildlife and Forestry	4	1			5
Zoology	1				1
Mining	1				1
Chemistry	1		1		2
Hydrology		1			1
Computer Science		1			1
TOTAL	10	3	2		15